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A CENTURY OF CIVIL ENGINEERING.

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The century which has just passed, the nineteenth of the Christian era, is distinguished from any of the preceding hundred-year periods in the world's history by the advances made in the co-operation of investigators in numerous branches of science in the formulation of doctrines regarding the nature and co-ordination of natural phenomena, which stand the test of experiment and calculation, thus leading to a nearer approximation to the understanding of the laws which govern such phenomena and so to the development into a profession of the "Art of directing the great sources of Power in Nature for the use and convenience of Man," which Art is entitled Civil Engineering. This definition is itself one of the most noteworthy products of the Nineteenth Century, and a study of the sequence of events and reasoning which led to its formulation is not without interest.

Ever since man became endowed with consciousness and the power of reasoning, he has been striving to solve the problems of the physical world around him in which he perceived matter in motion, which was

evidenced to his senses by sight and touch, by sound and taste and smell, but which was devoid of sentience, so far as he could discover. He observed at once that by its different manifestations his physical comfort was materially affected, and it did not take long for him to learn that certain sequences of sensation, of one sort or another, followed certain manifestations occurring singly or in combination, and then that the order of many such manifestations could be controlled by him at will, while that of multitudes of others could not be so controlled at first, their methods and causes not being appreciable by his unassisted senses.

But until about three hundred years ago there does not seem to have been any systematic and well-directed effort to investigate the reasons why material changes occurred naturally, or how certain changes could be artificially produced with certainty.

To discover the sequence of natural events is first of all an empirical task: facts must be observed systematically and recorded and then their combinations reasoned upon. Hypotheses can then be formed as to the probable effects of slightly different collocations and sequences of events, and these subjected to experiment and computation. An hypothesis cannot be established as a scientific fact until it has been verified by observation and also proven to be in accordance with mathematical laws. Tennyson's apothegm, that "knowledge comes, but wisdom lingers," is profoundly true.

Now, up to the beginning of the seventeenth century of the Christian era, there had been no organized physical experimentation, on a comprehensive scale, and intelligent reasoning therefrom. The speculations as to the laws of Nature which had been made from time to time had been purely efforts of the imagination, and were unsustained by either practical demonstration or analytical reasoning. Various hypotheses had been framed, on insufficient or incorrect premises, and some of them had been so near the truth as to actually delay the progress of the truth, by the appearance of exactness in the reasoning from them, up to a certain point.

Really, the civil engineer had been practicing his art and directing the forces of Nature for the use and convenience of man, but without any conception of what those forces were, or how they acted, or of why he did anything, or what the result of it would be, unless he had done the same thing before in the same way. He did not know that

the earth moved, and he had no idea why or at what rate a stone fell to the earth, or water ran down hill. He had no measure of heat or light, and used no power but that which the muscles of an animal produced. And yet he had built the Pyramids, the Parthenon and the Pantheon; had constructed aqueducts, canals and sewers; had regulated and maintained the rivers of China for thousands of years; and had just been recognized, on account of his labors in protecting the low lands of Holland and the shores of Italian rivers from the encroachments of the water, as holding a distinct rank among the workers of the world.

Of the application of the forces of Nature to aiding his labors, he seems to have been ignorant, except by the use of a flowing stream to turn a wheel. The earliest recorded application of this mode of producing power in England was in 1582 when Peter Moryss, a Hollander, procured from the City of London a franchise for five hundred years for supplying water to the city by pumping from the Thames, using a wheel driven by the ebb and flow of the tide under London Bridge.

With the beginning of the seventeenth century, the world entered on a new era of science, theoretical, and applied. The casual observation by a little child, of the curious optical effect obtained by looking through two pieces of glass, led to the invention of the telescope and the microscope, which disclosed to man objects beyond the reach of his unassisted vision. The swinging of a hanging lamp suggested to a thoughtful man the idea of an unseen force, and Galileo, by experiment and reasoning, discovered the law of terrestrial gravitation and first grasped the idea of force as a mechanical agent.

Turning his newly-invented telescope upon the heavens, he was the first man in the world to witness the actual motion of the planets and their satellites, and to prove that they and the earth revolved about the sun, as Pythagoras had imagined two thousand years before, Copernicus had asserted a hundred years before, and his own contemporary, Kepler, had reasoned from the imperfect data then possessed and had actually formulated the laws of their motion in forms which the science of our day confirms exactly. He was the first to conceive the theory of transverse strains in solids, but the facility of experimentation with fluids diverted his attention from more rigid bodies, and the fundamental principles of hydraulic science were established

by him and by his pupils and immediate successors in the fascinating studies he had introduced.

To Galileo, also, is due the invention of the thermometer, which enabled definite measurement to be made of the mysterious phenomenon of heat which his great contemporary philosopher in England, Lord Bacon, conceived to be "an expansive undulatory motion in the particles of a body whereby they tend with some rapidity toward the circumference, and also a little upward." But Bacon was two hundred years in advance of the physicists, and the century was occupied almost exclusively in the elucidation of the laws of gravitation as exemplified in the action of fluids. For the study of liquids and their action demonstrated that they were, under certain conditions of temperature, transformed into invisible and elastic substances governed in general by the same laws, and also that there were all around other similar substances which could not be condensed into liquid inelastic form, but could be weighed by the barometer which Torricelli invented in 1643. And so the laws of gases came to be investigated and formulated by Mariotte, who, to aid him in his researches, invented the rain gauge in 1677, and measured the liquids condensed from the atmosphere. The value of the data thus obtained, to the hydraulic engineer, was appreciated by the French engineers at once, and ever since 1681 records of the rainfall have been kept continuously at Paris, and the practice has gradually extended over the whole world. But it is worthy of note that fifty years after the invention of the rain gauge, Belidor, in his magnificent treatise on Hydraulic Architecture (1728), the first compendium of engineering theory and practice, in treating of the sources of water supply for domestic use, did not mention the rain gauge or the amount of rainfall, but dwelt on the divining rod as the recognized means of discovering subterranean streams of water.

The close of this century saw the final establishment of the law of gravitation by Newton's proof of its governing the whole material universe. And any review of the progress made during the century toward the understanding of the laws of Nature would be incomplete without allusion to the two great steps taken in it toward the facilitating of mathematical computations, the invention of logarithms at the beginning of the century and of the calculus at its close.

That heat produced dynamic effects had been recognized for ages.

That it destroyed some solids, that it converted others into different forms possessing entirely different properties, that it caused the dissipation and disappearance of liquids, were facts well established. That by its application to certain combinations of materials an explosive effect could be produced which overcame the force of gravity had been discovered three or four hundred years before when gunpowder was invented, but that a mechanical effect could be produced by the use of heat was not understood, and the nature of the phenomenon itself was not comprehended. It was looked upon by physicists as an "element" or primary form of matter, and in 1690 Stahl conceived the idea of "phlogiston," an elementary substance, invisible and inappreciable by the senses, which entered into the composition of combustible substances, and which, by the process of combustion, was separated from them and passed off in the form of corpuscles which, striking the sensory nerves, were perceived as heat. Sir Isaac Newton espoused this phlogiston hypothesis and also conceived that light was the product of certain corpuscles which were perceived by the optical nerves. The discussion of these hypotheses occupied the attention of the philosophers for the whole of the eighteenth century, and, in the meantime, the physicists were busy experimenting on the methods of utilizing the vapor into which heat converted water. By degrees, the steam engine was developed into a practical machine, capable of doing work which before could only be accomplished by animal labor, and the engineer availed himself of it in the handling of materials. But although the chemists had been striving for centuries to learn the composition of matter and the means of transforming and combining its several natural conditions, they had not, at the beginning of the nineteenth century, learned how to produce either heat or light, except by the aboriginal method of striking flint and steel together. In the lack of knowledge of the properties of these phenomena and the fact that they could be utilized on a large scale, there was no occasion for the devotion of any special class of men to their production and development. There were two other classes of phenomena which seemed as if they ought to be controlled by man, but the laws of which had so far eluded discovery, electricity and magnetism. So that, really, all that the civil engineer had to deal with was the force of gravity acting on such materials as the earth yielded him, in their natural state or as they could be modified by heat and manual labor.

But he had been making progress. In Italy, where the first application of science to construction had been made, the study of the laws of hydraulic science had been constantly pursued, and those laws applied to the regulation of the rivers; in France, ever ready to grasp new ideas and to pursue their application to practical results, the principles of hydraulics had been studied and applied to the construction of great canals, and to the supply of water to Paris, where, in 1671, water was pumped by a water wheel driven by the current of the Seine and distributed through cast-iron pipes. In England, Hugh Myddelton had supplied London with water, and, in 1638, Nicholas Vermuyden had been called in from Holland to protect the lands along the River Ouse from overflow, a task so well accomplished that his work stood for a hundred years and only failed then from lack of proper maintenance, the English having by that time apparently concluded that, as Dr. Franklin wrote in 1772, "rivers were unmanageable things," and, inspired by the success of the public waterways of France, turned their attention to the construction of canals and the improvement of harbors. Many important works of this class were built in England during the last half of the eighteenth century. The men by whom these works were constructed were not educated men or men experienced in scientific research. They certainly were men of great natural ability and good judgment, and capable of conceiving and executing great projects. One of the greatest of them, John Smeaton, who was the first Englishman to call himself a civil engineer, thus expressed his conception of the profession which he adorned:

"Civil engineers are a self-created set of men whose profession owes its origin not to power or influence, but to the best of all protection, the encouragement of a great and powerful nation, a nation become so from the industry and steadiness of its manufacturing workmen and their superior knowledge in practical chemistry, mechanics, natural philosophy and other useful accomplishments."

Smeaton was himself an investigator, but he is the only one of the civil engineers of Great Britain during the eighteenth century who strove to discover the laws which governed the operations of Nature.

The most eminent civil engineer in England in the year 1800 was Thomas Telford, who was born in 1757. Beginning life as a mason, he developed an extraordinary faculty of generalization, combined with an intimate acquaintance with the details of workmanship in all the methods of construction known in those days. In the building

of canals, highways, harbors, bridges and docks he displayed great grasp of the subject of the improvement of transportation facilities, as then existing, and great boldness of design and ingenuity in construction.

But it must be borne in mind that at that time the canal was considered the only possible mode of increasing facilities of transportation and reducing cost, no motive power except animal force was known, the metals were but little used in construction, and a framed structure adapted to bear heavy loads was unknown. As "an eminent mathematician," quoted in the *Edinburgh Review* in 1805, remarked:

"While we give ourselves infinite trouble to pursue investigations relating to the motions and masses of bodies which move at immeasurable distances from our planet, we have never thought of determining the forces necessary to prevent the roofs of our houses from falling on our heads."

It is related of Telford that when on one occasion he was consulted by a young man as to the advisability of his engaging in civil engineering, he said to him: "I have made all the canals and all the roads and all the harbors. I don't see what there is that you can expect to do."

His ideas regarding the training of the civil engineer are given at some length in his Personal Memoirs prepared shortly before his death.

"Youths of respectability and competent education who contemplate Civil Engineering as a profession, are seldom aware how far they ought to descend in order to found the basis of future elevation. Not only are the natural senses of seeing and feeling requisite in the examination of materials, but also the practised eye, and the hand which has experience of the kind and qualities of stone, of lime, of iron, of timber, and even of earth, and of the effects of human ingenuity in applying and combining all these substances, is necessary for arriving at mastery in the profession. For how can a man give judicious directions unless he possesses personal knowledge of the details requisite to effect his ultimate purpose in the best and cheapest manner?"

"It has happened to me more than once, when taking opportunities of being useful to a young man of merit, that I have experienced opposition in taking him from his books and his drawings and placing a mallet, chisel or trowel in his hand, till rendered confident by the solid knowledge which experience only can bestow, he was qualified to insist on the due performance of workmanship and to judge

of merit in the lower as well as the higher departments of a profession in which no kind or degree of practical knowledge is superfluous."

This is doubtless good, sound doctrine, but it does not betoken any very lofty conception of the aims and ends of the profession. But during the first quarter of the nineteenth century Telford stood at the head of the profession of civil engineering, and when, in 1820, the recently formed association of its practitioners for mutual advancement in science, which was termed The Institution of Civil Engineers, desired a prominent leader, he was chosen its President, and held that office until his death in 1834. He does not appear to have contributed to The Institution any papers or discussions on engineering subjects.

Among the members of The Institution at that time was a man thirty years the junior of the President, who, like him, had risen from humble origin, and by his own exertions attained a high rank in the profession, and who, rather oddly, had the same fore-name, and a surname of two syllables the initial and final letters of which and the vowel sounds of which were the same as Telford's. This similarity of name has led to some confusion and sometimes to the attributing to one of these men the sayings and doings of the other.

Thomas Tredgold, born in 1788, began life as a carpenter, but soon devoted himself to the study of engineering science and its practice in the office of the Chief Engineer of the Ordnance Bureau. He early recognized the deficiency of the knowledge then existing as to the nature and strength of the materials used in construction, and he studied, experimented and reasoned systematically, and published the results of his labors. His Treatise on Carpentry, in 1820, was the first published attempt to determine scientifically and practically the data of resistance of beams to transverse flexure. During the next seven years he contributed to the *Transactions* of the Institution of Civil Engineers papers showing the mode of application of science to engineering problems, and he also published treatises on Warming and Ventilation, on Steam Navigation, on Railroads and Carriages, and on the Steam Engine. It was to him that the Institution turned when it wished to apply for a Royal Charter, in 1828, and requested him to prepare a definition of Civil Engineering.

As we look back upon the history of science, theoretical and applied, during the first quarter of the nineteenth century, we can

see how a new definition of the profession of Civil Engineering was needed at that date.

At the very beginning of the century there had occurred a marvelous revolution in the conception of the nature and operation of the laws governing matter and its motion. Lavoisier had revolutionized chemical science and Dalton had propounded a theory of atomic constitution of matter which has been sustained by observation and reason. All matter is composed of a few primal elements in an atomic or minutely subdivided form. These atoms have varying chemical affinity for each other, and, combining in certain proportions, form molecules of matter of various kinds. The study of these combinations has been the business of chemists for the last hundred years, and the laws of combination have been so successfully elucidated that many forms of matter which before were found only in a state of Nature can now be artificially produced, and many other forms have been produced which are never found in Nature and which are useful for purposes and under conditions where no natural product can be used to advantage. The impetus given to chemical research by the formulation of Dalton's theory was sufficient to establish the fact, early in the century, that chemical affinity was a source of power which could be directed by man intelligently and with prospect of advantage.

Just with the incoming of the century, too, came Rumford's demonstration of the fact that heat was not a material substance, but only a mode of motion. Almost simultaneously was propounded the theory of Thomas Young, that light, too, was not material, but was simply due to vibratory motion in an all-pervading medium to which he gave the name of the luminiferous ether.

It was in 1800, too, that Volta demonstrated that an electric current could be artificially produced. How it could be controlled and applied to practical use did not yet appear, but a new direction had been given to the minds of those engaged in physical research.

As it became manifest that chemical affinity and heat and light could be controlled and directed and converted into Energy, as Young termed it, the men who had been trained in utilizing the force of gravity turned their attention to the development of these newly understood sources of power. Fitch and Fulton, with the aim of reducing the cost of water transportation, succeeded in applying

the steam engine to the propulsion of boats, and Trevithick made successful application of steam propulsion to vehicles on land. Murdock had proved that illuminating gas could be produced and distributed to consumers. The civil engineers of the day had seized on all these inventions and discoveries, and in both Europe and America were designing and constructing works to render them useful to the greatest number of people.

Reviewing then what had been accomplished during the first quarter of the century, Tredgold could not but perceive that civil engineering was something broader and more comprehensive than the mere construction of harbors, breakwaters and canals, and he presented on January 4th, 1828, in response to the request of the Institution, this ever memorable definition of Civil Engineering:

*"Civil Engineering is the art of directing the great sources of power in Nature for the use and convenience of man; being that practical application of the most important principles of natural philosophy which has, in a considerable degree, realized the anticipations of Bacon, and changed the aspect and state of affairs in the whole world."

After a brief sketch of the objects of Civil Engineering, he added: "The real extent to which it may be applied is limited only by the progress of science; its scope and utility will be increased with every discovery in philosophy, and its resources with every invention in mechanical or chemical art, since its bounds are unlimited, and equally so must be the researches of its professors."*

A more concise and comprehensive definition of a great truth can hardly be conceived. From a physical and intellectual standpoint, a nobler aim for the exercise of the mental powers cannot be imagined than the direction of the great sources of power in Nature for the use and convenience of man. Psychology deals with mind alone, Physics considers the nature and the laws of matter, but Civil Engineering treats of the intelligent direction of the laws governing matter so as to produce effects which will reduce to a minimum the time and physical labor required to supply all the demands of the body of man and leave more opportunity for the exercise of the mental and spiritual faculties. Philosophy, Physics and Civil Engineering must work hand in hand. The philosopher must imagine, the physicist prove by experiment and mathematical computation, and the engineer apply to practice the laws of matter. Each must keep himself informed of the progress made

* *Minutes of Proceedings*, Institution of Civil Engineers, Vol. xxvii, p. 181.

by the others and must aid them by suggestions as to the lines on which research needs to be carried forward. The civil engineer, in attempting to solve some problem of construction, finds that he needs a material which shall possess a certain quality which he cannot discover that any natural product possesses. He calls the chemist to his aid, and he, from a study of the combinations of existing forms of matter which most nearly approach the desired ideal, reasons that some special combination of elements will entirely fulfil the conditions, and he experiments to find whether such combination can be made. Sometimes he is successful in his first attempt and sometimes not. But, whatever the result, he has added to his knowledge of the laws of combinations and has furnished to the philosopher fresh data for his generalizations and to the engineer a new material for his use.

It not infrequently occurs that, from investigations made for a specific purpose, results are obtained of the greatest usefulness for an entirely different purpose. Thus, in 1855, when Henry Bessemer, inspired solely by that desire "to kill something" which is alike the ruling passion of the rudest savage and the most highly civilized man, bent all his energies to the production of a metallic combination which should be able to resist the force of the highest explosive and so enable a cannon ball to be projected from a gun to a greater distance than ever before, he discovered a method of expelling all foreign substances from iron and then adding a minute quantity of another element, carbon, in such proportions that the original mass was materially changed in character and made more ductile, stronger and stiffer. The product was exactly what the railroad engineer wanted at that time for the bearing surface of his roadway, and the material which had been sought for destructive purposes became a most important factor in facilitating the transportation of men and goods with certainty and safety at high speeds.

As the knowledge of the nature of steel and the precise methods in which it can be manufactured have progressed, the engineer has gradually come to know just what he wants and how it can be produced, and, in his specifications, requires that the particular material of this class which he desires shall be of a certain chemical composition and also possess certain characteristics. The same is the case with almost every material which enters into the construction of engineering works of the present day. Matter in its original state is rarely used. Its

chemical condition must be transformed before the engineer can utilize it with any confidence. That almost any desired transformation can be affected was not realized until late in the century. Starting with the atom, the ultimate particle of matter so far comprehended by us, the chemist found that several different kinds of atoms could be identified, and that these would combine in certain ways according to laws which could be formulated. But in the application of these laws and the tabulation of the results gaps were found to exist which could not be filled without the supposition that other elements existed than those already known. The existence of such elemental substances was confirmed by the revelations of the spectrum analysis, and, later on, several of such elements have been actually identified by the use of the electric current in creating vibrations in the ether. The limit is probably not reached yet, but as each new element is discovered its affinities are sought by the chemist, its sensibility to various forms of vibratory motion are investigated by the dynamist, as we may term the physicist who is seeking the laws of either heat or light or electricity, and then it is the function of the civil engineer to study how it can best be applied to the use and convenience of man. For, ever since the beginning of the nineteenth century, the evidence has been cumulative that matter in motion accounts for all physical phenomena, that motion produces energy, that energy is never wasted but is simply transformed, and that it manifests itself to the senses of man in various modes which are appreciable by the several organs of sense.

What our senses recognize as chemical affinity, heat, light and electricity are simply conditions of matter induced by vibrations or quivers or waves or strains, whatever we may call them, of different kinds and at different velocities. Neither matter nor motion can be originated by man, but, by a careful study of the sequence of events, control can be acquired of their modes of interaction, and natural phenomena can be artificially reproduced and other phenomena be produced. The intelligent application and direction of such means of control is the function of the civil engineer.

With the advance of science, the scope of civil engineering widened and advanced. The study of the action of forces induced analytical investigation of the means by which forces could be resisted and the best results obtained from proper distribution and arrangement of materials of different kinds. Steamships and locomotive engines were

constructed by which the products of the earth and the manufactures of man, by machines and methods not before conceived, could be transported across the seas and overland by artificial highways and across bridges of previously unimagined span; and light and heat and electricity and water could be delivered in the apartment of every person to be used at will.

It was in the carrying out of the delivery of pure and wholesome water and the removal of its unused surplus that the civil engineer first was called on to deal with organic life. That minute organisms affected the comfort and the health of man had been recognized for hundreds of years. In the middle of the seventeenth century Leeuwenhoek, a Dutch maker of microscopes, discovered and described bacteria, and Nicholas Andry, a pathologist, ascribed to them the causation of disease. But later scientists discarded the idea, and it was not until 1831 that any real advances were made in the study of these micro-organisms, and it is only within the last twelve years that it has become thoroughly recognized that the regulation of the growth of living organisms in air and water and sewage is necessary and practicable, and comes within the domain of civil engineering.

Indirectly, however, biological research has been one of the most important factors in the progress of engineering science, by calling the attention of students of physics to the fact that advance and not retrogression is one of the fundamental laws of Nature. For the first half of the century, the old ideas of cosmogony, based on an hypothesis unsupported by proof, were prevalent everywhere. It was assumed that the world, in all its details, had been created perfect and had since been simply deteriorating and tending to a final dissolution. "Change and decay, in all around I see" was the dogma of the theologian, the philosopher and the scientist alike. While it had come to be recognized that the forms of inorganic matter could be changed by man, and that, by the exercise of man's intelligence, certain characteristics of organic matter and the vital forces with which it was imbued could be modified and perpetuated, it was not considered possible that the superior intelligence which controlled everything could modify or transform such characteristics in any special form of matter.

But in 1859, Charles Darwin, after twenty years of study of the sequence of events in biological phenomena, demonstrated that there was an intelligence beyond that of man, which was constantly acting

to change and modify the forms, the habits and the mode of life of animals and plants, and that such action resulted in the perpetuation of the fittest type of organism. The proof was irrefragable, and the effect of his wonderfully clear exposition of the processes by which his conclusions had been reached was marvellous in inducing a co-ordination of thought and a co-operation in methods of procedure in intelligent research in the investigation of all natural phenomena, whether relating to organic or inorganic matter.

In considering the means of directing the great sources of power, the psychological element must not be forgotten. A mere intellectual application of the laws discovered by physical research is not enough to make a civil engineer. Breadth of view, the faculty of analyzing what has been done so as to discover how and why some enterprises have been successful and others have not, and the ability to forecast the future, are essential. These qualities are largely natural, but may be cultivated to a great extent by study and experience. That there has been a wonderful advance in this direction during the nineteenth century is shown by the great number of civil engineers who hold positions of prominence in the management and control of large enterprises which require the exercise of faculties which cannot be acquired in any other way than by experience in the designing, construction and management of engineering works.

A prominent factor in causing this advance in engineering science which has occurred simultaneously on the Continent of Europe, in Great Britain and in America, has been the collaboration of scientists. Early in the century it became evident that the multiplication of lines of research demanded a differentiation of the labor of their prosecution and a close co-operation of the workers in any special line, and various associations of specialists were formed to promote various branches of scientific research. By the middle of the century it had become apparent that Civil Engineering was not the prosecution of a specialty, but was the co-ordination and direction of the work of all specialties in Science and its applications. And so in 1852, James Laurie and his associates, following the example of their English brethren, founded The American Society of Civil Engineers, the first and only National Organization devoted to "the professional improvement of its members, the encouragement of social intercourse among men of practical science, the advancement of engineering in its

several branches and the establishment of a central point of reference and union for its members." To the privileges of its membership may be admitted not only every "professional engineer," but also "any person who by scientific acquirements or practical experience, has attained a position in his special pursuit qualifying him to co-operate with engineers in the advancement of professional knowledge and practice." This meeting of that Society, which now has 2 500 names upon its rolls of membership, and owns a commodious society house with a reference library of some 40 000 titles, is sufficient proof of the wisdom of its founders.

Recognizing, then, that progress is a law of Nature, the acceleration of progress is the aim of Civil Engineering. It strives to simulate the results of the slow processes of Nature, by causing the sources of power to act rapidly in any desired direction. Appreciating, too, the fact that there is constant progress, and that what now seems admirably adapted to our needs may in a short time require to be superseded by improved structures and processes, the tendency of the time is toward the production of works which will have a definite term of life, rather than toward the construction of everlasting monuments. We see that in the old nations, where the effort to build for eternity was made, time has outstripped the intent of the builders and what is antiquated is useless, and we see the same thing in our own streets to-day. The idea of building a monumental structure which will hand one's name down to future ages is a fascinating one, but it is simply a survival of the engineering of the Pharaohs.

The most thorough exemplar of the condition of civil engineering at the beginning of the twentieth century is the modern office building in a great city. One hundred years ago, the man of enterprise who resided 50 miles from a large city and wished to consult an engineer regarding a project for a new canal, arose before daylight, struck a spark from his flint and steel, which falling on a scrap of tinder was blown by him into flame and from that a tallow dip was lighted. In the same primitive manner, the wood fire was kindled on the kitchen hearth and his breakfast was cooked in a pot and kettle suspended from the iron crane in the fireplace. Entering the cumbrous stage coach, hung on leather springs, which passed his door, he was driven over muddy roads, crossing the narrow streams on wooden trestle bridges and the navigable rivers on a ferry boat, the paddle wheels of

which were turned by a mule on a treadmill. At last he was landed in the city where he walked through dirty streets paved with cobble stones until he reached his destination, a plain three-story brick building founded on sand, with a damp cellar and a cesspool in the back yard. Entering a dark hall he climbed a wooden staircase and was ushered into a neat room, rag-carpeted, warmed by a wood fire on the open hearth and lighted by a sperm oil lamp with one wick, for it was dark by this time. No wonder that before proceeding to business he was glad to take a good stiff noggin of New England rum.

To-day, his grandson, living at the old homestead, while comfortably eating his breakfast, which has been cooked over a gas range, reads in his morning paper that the high dam of the irrigation reservoir in Arizona, in which he is interested, sprang a leak the day before, and he telegraphs to his engineer in the city that he will meet him at his office at noon. Then, striking a match, he lights the lamp of his automobile which is fed by petroleum brought 200 miles underground in pipes from the wells, rolls over macadamized roads to the railroad station, where he boards a luxuriously appointed train, by which he is carried above all highways, through tunnels, under rivers, or across them on long-span steel bridges, and in an hour is deposited in the heart of the city, where he has his choice of proceeding to his destination through clean and asphalt-paved streets in electric surface cars at 9 miles an hour, elevated steam cars at 12 miles an hour, or through well-lighted and ventilated tunnels at 15 miles an hour. Reaching the spot his grandfather had visited, he finds there a huge and highly decorated building, twenty or more stories high. Founded on the primeval rock, far below the surface of the natural ground, the superjacent strata of compressible material having been penetrated by caissons of sheet metal sunk by the use of air, compressed by powerful pumps driven by steam or electricity generated at a power station half a mile or more away, and these caissons filled with a manufactured rock such as the ordinary processes of Nature would require millions of years to produce, there is erected a cage of steel, the composition of which has been specified, and the form and mode of construction of which have been so computed that the force of the elements cannot overthrow the structure or even cause it to sway perceptibly. Towering above the courts of Law, the temples of Religion and the palaces of the Arts, the meshes of this mighty cage are filled

with products of the earth, the mine and the forest, transformed so as to be strong and light and incombustible, and all interwoven with pipes and wires, each in its proper place and noted on the plans. In one set of these pipes there is pure water, which has been collected from a mountain area of igneous geological formation, depopulated and free from swamps, on which a record of the daily rainfall is kept, and in which impounding reservoirs have been constructed by masonry dams across its valleys. From these reservoirs, the water, after filtration through clean sand, is conveyed 30 or 40 miles through steel or masonry conduits to covered reservoirs whence it is drawn as needed through cast-iron pipes to the building where it is to be used, and there distributed to all parts of it, chilled nearly to the freezing point through one system of pipes or heated nearly to the boiling point, through another system. Another set of pipes carries steam which, passing through radiators, keeps the temperature of the air throughout the building at the proper standard for comfort. Sanitary conveniences are provided everywhere, and all wastes are consumed within the building by the surplus heat generated, leaving only ashes to be removed. Wires convey electric currents to all points, so that the occupant of a room, sitting at his desk, can by the touch of a button ventilate his apartment, illuminate it, call a messenger, be kept informed of every fluctuation in the markets, converse with anybody who is not "busy" within 40 miles of where he sits and if entirely "up to date" can require his autograph and portrait to be reproduced before his eyes for identification. He dictates his correspondence and his memoranda, and "takes his pen in hand" only to sign his name. He need not leave his seat except to consult the photograph hanging on his wall, which shows to him the latest condition of the mine, the railroad, the arid lands irrigated, the swamps reclaimed, the bridge in progress, the steamship, the water-works, the tunnel or the railroad, the dam, the filter or the sewage works, the town, the machine, the power plant or the manufacturing establishment in which he is most interested.

Entering the brilliantly lighted hallway of this building, the air of which is kept in circulation by the plunging up and down of half a dozen elevators, the visitor is lifted at a speed of 500 ft. a minute, past floor after floor, crowded with the offices of financiers, managers and promoters of traffic and of trade, lawyers, chemists, contractors,

manufacturers, to the headquarters of the controlling genius of the whole organism, the Civil Engineer. For he it is to whom all the members of this microcosm must apply for aid and advice in the successful operation of their respective occupations. It is not his to mechanically transform elements into matter, or matter into other forms, or to show how energy may be produced, but to direct the application of energy to the various forms of matter, original or produced, in such way as to bring about the most satisfactory results in the most speedy and economical manner.

He has grown with the growth of the nineteenth century, and is, so far as the relations between man and matter are concerned, its most striking product. And so, while the definition given in the "American Edition of The Encyclopædia," which appeared at the beginning of the century, that: "Civil Engineers are a denomination which comprises an order or profession of persons highly respectable for their talents and scientific attainments and eminently useful under this appellation," is still true, it is hardly probable that the compiler of the Twentieth Century Encyclopædia will be content to let it stand without further explanation.

But the end is not yet: there are still many problems of Nature unsolved. The experience of every day shows that there are sources of power not yet fully developed, and we cannot but say with the great poet:

> "I doubt not through the ages one increasing purpose runs,
> And the thoughts of men are widened with the process of the suns."

MEMOIRS OF DECEASED MEMBERS.

JAMES COLWELL ALDRICH, M. Am. Soc. C. E.*

DIED APRIL 3D, 1900.

James Colwell Aldrich was born at Chopmist Hill, Scituate, Providence County, R. I., on July 24th, 1838. The land comprising Chopmist Hill lies on the west side of the seven-mile line included in the original ground purchase of Providence Plantation, which was laid out and conveyed by a committee of the early proprietors, consisting of Henry Harris, of Providence, and John Walton and Richard Steere, of Gloucester, the last named being Aldrich's ancestor and a Justice of the Court of Common Pleas for the County of Providence during many years of the reign of George II.

James C. Aldrich's father's name was James, and he belonged to the well-known New England family. His mother was Abigail Colwell, whose emigrant ancestor to America, Robert Colwell, was born in Warwickshire, England, in 1630, came to Providence in 1653, where he settled, and removed to Long Island in 1667, where he died. Abigail Colwell's forefathers were educated in the art of war and the kindred sciences. Her grandfather's brother, Colonel John Colwell, commanded the Third Regiment, Rhode Island Colonial Brigade, and her grandfather, William Colwell, married Lucia Arnold, one of the three daughters of Caleb Arnold, the patriot known as the father of the Revolutionary family, consisting of eight sons and three sons-in-law, who served in the Continental Army. One son, Othonial Arnold, received his death wound at the battle of Bunker Hill, and Caleb Arnold, the patriot, was sent as Deputy to the Rhode Island General Assembly from 1773 to 1778, was paid State bounties in 1778, and served on the War Committee and the Committee for Recruits in 1780. This family of Arnolds is of great antiquity, having their origin among the ancient Princes of Wales, and, according to a pedigree recorded in the College of Arms, they trace from the second son of Cadwalader, King of the Britons.

James C. Aldrich was graduated from the Scientific Department, Dartmouth College, in the Class of 1859, and immediately secured a position on an engineering party commanded by Colonel Silvester Mowry, fitting out at Providence, to journey overland from St. Louis to Arizona. Indian hostilities caused delays, and, tired of waiting, he sailed on the ill-fated steamship *North Star*, *via* the Isthmus, for California.

* Memoir prepared by Miss D. Aldrich.

After an eventful passage of disaster and danger, he arrived in San Francisco, where he served for a while in the Land Department of the Law Office of Giles H. Gray.

He taught school at the Mission of San José, of which C. L. Beard, who, with others, afterward founded and built Washington College, near that locality, was a Trustee. While thus engaged, Colonel Fred. Lander tendered him a position on the overland wagon road surveys,* in which Colonel Lander took command of all available forces. He changed the programme, however, and, later, came by the old Butterfield Route, Los Angeles and Ft. Yuma, up the Gila River, through Tucson, Apache Pass, El Paso, Ft. Davis and Ft. Chadbourn, to the vicinity of old Ft. Graham, Texas.

This was after the John Brown raid, and civil war was imminent. He then pushed on through the Indian Territory and Ft. Smith to the terminus of the Pacific Railroad, then westward only 30 miles from St. Louis.

He next taught in a Military School on the Hudson, and worked at intervals for Chickering and Mapes, Civil Engineers, at 18 Wall Street, New York City. While there he made some of the earlier preliminary surveys, under charter for a railway up the west shore of the Hudson River; but his active life commenced on forming the acquaintance of George P. Hopkins, a civil engineer, by whom he was introduced to Israel Smith, Engineer of the New Jersey Railroad and Transportation Company, under whom he was assigned a position on Hopkins' work, the construction of the Bergen Point Railway.

He next went with the company's experienced Locating Engineer, Edward Everett, on the final location for the Rahway, Woodbridge and Perth Amboy Railway, and in the following spring aided the late I. C. Chesbrough, on the location of the Taunton, Somerset and Fall River Railway. He now became permanently connected with the Engineer Corps of the New Jersey Railroad and Transportation Company (United Division, Pennsylvania System), and for several years during the Civil War served as Assistant Engineer and Superintendent of Construction on new lines and terminals.

He was also employed on the earlier topographical surveys for the maps and plans, to go before the Legislature at Trenton, for the water-works at New Brunswick, N. J., of which E. Millard Smith was Acting Chief Engineer.

His next work was on the construction of the Flushing and Manhasset Railway extension on Long Island.

Mr. Aldrich then became associated with John Houston, Chief Engineer of the Long Dock and the Bergen Tunnel and Erie Railway; Houston acting as Consulting Engineer on all lines seeking connection

*See advices to the Interior Department, from Magraw's Section, Wagon Road Expedition, Indian War.

with the Erie and entrance to New York City by way of the Bergen Tunnel, and Aldrich performing professional duty on location on the rugged line from Hancock through Delaware County, and on the New York and Newburgh, known as the short cut, the Newark and Paterson and the New Jersey Southern, extending to Atlantic City and Penn's Grove, opposite Wilmington, on the Delaware.

On these different roads his professional lines were in conjunction with those of George Earl Church, M. Am. Soc. C. E., later of the Amazon River Improvement, Edward Everett, L. D. Bruyn and William S. Sneden, Chief Engineer and General Manager of the New Jersey Southern Railway.

It was during this era of a busy life that he was called to Brooklyn, N. Y., by the late Benjamin D. Frost, M. Am. Soc. C. E., afterward of Hoosac Tunnel fame, to push with diligence the topographical surveys to be used as a basis upon which Mr. Fred. Law Olmsted was to make a study and design to lay before the Legislature at Albany to advocate the interests of the Brooklyn Park bill.

Mr. Olmsted's plan proved a success, and for over four years, as Division Engineer, Mr. Aldrich gave to this great work his undivided attention.

Mr. Aldrich next went to Chicago, in the interest of Messrs. Olmsted and Vaux, Landscape Architects, on the layout of Riverside, a suburban city. On his return to New York he took charge of the construction of the Spuyten Duyvil and Port Morris Railway (Vanderbilt's Hudson River Railway entrance into Harlem); then he went with Mr. Edward Everett on the difficult location of the Rochester, Mt. Morris and Munda Railway, and in the same winter completed the topographical survey for a study and design for a cemetery at Middle Hope, on the Hudson, for the City of Newburgh. Following after came the nice surveys for the extension of the northern limits of New York City, and then, in company with the late John Houston, the examinations and triangulations of the Passaic River and its tributaries, in the interests of the United Societies of the State of New Jersey.

Mr. Aldrich now made a four-years' engagement to accompany Mr. Houston to Peru and Bolivia, but, on the eve of departure, was allowed to cancel it and accept a Government position, first under the late George H. Elliott, M. Am. Soc. C. E., Engineer Secretary of the Light-House Board, U. S. A., and later as Aide and Assistant Engineer to General O. E. Babcock (Engineer of Public Buildings and Grounds, Chief Engineer of the Washington Aqueduct and Private Secretary to President Grant).

Mr. Aldrich was elected a Member of the American Society of Civil Engineers on May 7th, 1873. In October, 1873, he was appointed

Assistant Landscape Engineer, Department of Public Parks, New York City.

After completing this engagement he went to Rhode Island and entered upon the task of tracing a double-track, medium-grade railway location from tide water to some point on the Connecticut River between Windsor Locks and Springfield, Mass., to be constructed in the combined interest of the Connecticut-Poughkeepsie Bridge System, Boston and Albany, and Vermont Central Railways. This was a project which had enlisted the services of the late I. C. Chesbrough, as early as 1863, but as there were no topographical data of the intervening territory, and as all previous profiles had ended high in the air, the route was generally considered impracticable. Aldrich, however, from his earlier acquaintance with its New England features, was prone to believe in its available possibilities, and associated with himself the veteran locator, Edward Everett, and A. D. Beach, who had already made such a success of stadia measurements on the canal surveys across the Isthmus. He entered upon an exhaustive examination of the three most probable lines, and finally established a favorable and scientific location. Afterward, he rendered material aid in securing the charters in the three States.

He next accepted a position on the working up of the maps, plans and contracts of the Riverside Avenue Improvement, Department of Public Parks, New York City, and was appointed Superintending Engineer, which position he retained for two years, until a change occurred in the political complexion of the Park Commission. After this (in the interest of Austin Corbin and Western bankers), he took charge of a heavy railway construction on the south side of Long Island.

He was now tendered two positions, one in an unhealthy portion of Mexico and the other on a mountainous line to connect with the Santa Fé System. But the effects of past exposure and the inroads of chills and fever on an extremely sensitive organization had begun, and his physician called a halt.

Ambitious and active, his work had required brave bodily toil, courageous persistence and studious thought. It cost him, too, what may go to hearten us, and what we are apt to forget—frets, worries and contentions—and he learned, in the school of many teachers, benign forbearance and self control. Perfect integrity was observed in all his affairs. His last feeble years were passed at the homestead where he was born, and which he took great pleasure in improving.

EDWARD ARNOLD CORREA, M. Am. Soc. C. E.*

DIED JUNE 24TH, 1900.

Edward Arnold Correa, only son of Gabriel A. and Sarah Woods Correa, was born in the Island of St. Thomas, Danish West Indies, on November 7th, 1855.

His father was a gentleman of culture, with marked musical taste, and, having had the benefit of a European education and of extensive travel, was a linguist of no mean ability, speaking five or six languages fluently.

Mr. Correa's mother was of English parentage, her father having graduated at Oxford College. He was a planter, owning estates in St. Croix, Danish West Indies, which were quite valuable until the emancipation of the slaves by the Danish Government and subsequent disorder destroyed their value.

When but seven years old Mr. Correa's father died, and his mother, considerably reduced in fortune, came with her young son and daughter to the United States, locating in Brooklyn, N. Y., where the subject of this memoir attended the public schools until his fifteenth year. This was practically all the schooling he received, as his mother then removed to Iowa; but he had already earned the reputation of being a bright pupil and a voracious reader. He was employed in a bookstore at Mt. Pleasant, Iowa, for a few years, and, continuing his studious habits, improved his mind by reading the best books.

He entered the offices of the Chicago, Burlington and Quincy Railroad in 1879, without preliminary training, and, by close application and study, advanced rapidly in his chosen profession, being at all times noted for the careful, painstaking manner in which he did any work entrusted to him. He was repeatedly employed by men under whom he had served before, and his going to Mexico was due to the offer of a situation by former employers.

He remained with the Chicago, Burlington and Quincy Railroad until 1881, serving as Rodman, Topographer, etc. In 1881 he was Topographer and Leveler on the Utah and Northern Branch of the Union Pacific Railroad.

In 1882 he commenced work for the Atchison, Topeka and Santa Fé Railroad Company, and, with the exception of one or two short intervals, he remained with that company until 1888. During these years he served as Leveler and Topographer on surveys, as Division Engineer on construction and as Assistant Engineer in the Building and Water-Supply Departments.

* Memoir prepared by the Secretary, from papers on file, and from information supplied by Lewis Kingman, M. Am. Soc. C. E.; J. T. Norton, M. Am. Soc. C. E., and Mrs. H. C. Jones.

In 1889 he served as Transitman on the location, and as Division Engineer on the construction, of the Fort Worth and Rio Grande Railway, from Granville to Stephenville, Texas.

In 1890 and 1891 he became Locating Engineer and Assistant Engineer in charge of the construction of the Mexican Pacific Railroad, a proposed transcontinental line from Tonala to Frontera. During this period he also made a reconnoissance of a line from Alvarado to San Andres Tuxtla, in Vera Cruz, Mexico, and located 20 kilometers of that line.

From April to December, 1891, he was one of the Assistant Engineers on the Tampico Harbor Works, under A. F. Wrotnowski, M. Am. Soc. C. E.

During 1892 and 1893 he was Locating and Resident Engineer on the Mexican National Railroad across the Isthmus of Tehuantepec. In reference to this piece of work the following is quoted from a letter from the Chief Engineer of that road, and found among Mr. Correa's effects:

"I wish to express to you my appreciation, not only of the thoroughly conscientious work you have done for me, but also as to your ability as an Engineer. You have had charge of the location of this line from the Sarabia to the Jumuapa Rivers, which I consider by far our most difficult piece of work. Owing to the configuration of the country, Ship's Pass being the only point at which you could cross the range between these two rivers; to get a line up to it from the Sarabia, and from it to the river Jumuapa again and not carry long supported grades; to avoid rock cuts, which would not only have been nearly impossible but impracticable, from their cost, and get a line as you have, both with such good alignment and so cheap, has, I think, been the greatest engineering feat accomplished here on the Isthmus, and well shows your ability. For your prompt attention to all instructions, for your earnest manner in performing your duties, allow me to thank you. Wishing you every success in your profession, and that you may reap those rewards which you so richly deserve, I remain,

"Yours very respectfully,

"S. B. Burton, *Ch. Eng. and Gen. Manager.*

"Coatzacoalcos, February 4th, 1893."

During 1894 and 1895 Mr. Correa was engaged in private practice in Mexico, in various classes of work.

In July, 1895, he became Assistant Engineer on the Mexican Central Railroad, under Lewis Kingman, M. Am. Soc. C. E. He was engaged on reconnoissance surveys and reports of lines in various parts of Mexico until about July, 1897. He was then engaged on location, and had charge of various pieces of construction. He then became Division Engineer at Aguas Calientes in charge of Yards and Shops plant.

Shortly after this, Mr. Correa was sent to Parral, in Chihuahua, where he was engaged in supervising the construction of a branch of the Mexican Central Railroad. He was employed upon this work at

the time of his death, which occurred in camp, on June 24th, 1900, after an illness of a day or two.

Mr. Correa was elected a Member of the American Society of Civil Engineers on March 7th, 1900.

He never married, but supported his mother up to the time of her death, September 1st, 1898, and it was in fulfillment of her expressed wish that he sought membership in this Society.

Mr. Correa was a man utterly incapable of a mean or dishonest action, and, in an unostentatious way, one of the most charitable. He was a true friend, and was sincerity personified in all his dealings with his fellowmen. He was at the time of his death one of the ablest railroad engineers in Mexico. He was an indefatigable worker and was conscientious to a fault. His ideals were high, and his ambition was to do anything to which he set his hand, not as well, but better, than others could do it.

In his death the Society has lost a useful and honored member, and one who was universally respected, even by his enemies.

WILLIAM GIDDINGS CURTIS, M. Am. Soc. C. E.*

DIED JUNE 15TH, 1900.

Like many other natives of Connecticut, the subject of this memoir was of good colonial stock, tracing his lineage back hundreds of years in Essex County, England. The descendants of William Curtis, his ancestor, who came to the colonies in the ship *Lion*, in 1632, took a prominent part in the colonial life, and, when the final separation from the old country came, several of the Curtises figured in the great struggle for independence.

Mr. Curtis was born at Bridgeport, August 19th, 1849.

At the age of fifteen, he removed with his parents to San Diego Cal., thereby doubtless changing the whole trend of his life and fortunes.

At that period, there was a ready market on the Pacific Coast for probity and ability, even in the very young, and, but a year later, 1865, Mr. Curtis obtained employment with the Central Pacific Railroad Company, and began a career of success no more marked than deserved, and whose achievements only terminated with his life.

Most engineers commence the practice of their profession after a more or less complete course of study, but Mr. Curtis, beginning as a rodman at the age of sixteen, was obliged to acquire most of its theory during such leisure hours as were left him from active duties in the field and office. He passed through nearly the entire period of location and construction on the Central Pacific Railroad, an experience which profited him during his whole professional career.

He became successively Assistant Engineer, Resident Engineer, Assistant General Superintendent, and Superintendent of Track, and finally reached the position of Assistant to General Manager, and Engineer, Maintenance of Way, of the Pacific System of the Southern Pacific Company, comprising, at the time of his death, nearly 6 000 miles of railroad, which position he retained during the rest of his life.

Owing to the total lack of timber on most of their lines of railroad, the Southern Pacific Company early turned their attention to the subject of timber preservation, in which they have had marked success and have perhaps done more than any other railroad company in America, if not in the world. The achievements in this regard have rightfully been largely credited to Mr. Curtis, under whose able direction the work progressed until, at the present time, practically all the timber and ties used in or about the roadway, excepting redwood, are

* Memoir prepared by John D. Isaacs and Virgil G. Bogue, Members, Am. Soc. C. E.

treated with creosote and chloride of zinc, respectively. Mr. Curtis was an authority in this science, and one or more of his papers are among the best contributions that have appeared on this most important subject.

As Engineer, Maintenance of Way, Mr. Curtis kept himself well informed by observation, reading and discussion, and was fully abreast of the times. His enthusiasm, however, was tempered by that judgment which comes only from experience and attrition with men and the duties of life. His constant aim was to do the best possible under the conditions and circumstances presented.

His advice was frequently sought in relation to the business of other departments of the railroad, and there was scarcely a work or study related to the railroads of the Southern Pacific Company with which he did not have more or less to do, and always with credit and success. He was one of the controlling forces of that vast property.

From boyhood to his last day he remained faithful and industrious in the same employ, and it is fair to say that Mr. Curtis, more than any other, was the author of the present perfected methods and organization of the Maintenance of Way Department of the Southern Pacific Company. His duties covered thousands of miles of railroad and a wide range of climate, from the tropic heat of the Colorado Desert to the Arctic cold of winter in the Pequod Hills; from the restful scenes and orange groves of the Los Angeles Valley to the deep snows of the Sierra Nevada and Siskiyou Mountains, or from the sunny skies of the San Joaquin to the storms and floods of the Soledad and Sacramento Cañons, or the cloudbursts of the Arizona Plains. There was no time of the year when his presence might not be required on some distant portion of the property where inundation or snow impeded traffic or threatened disaster. But he was full of resources and always ready for any emergency, and in the process of time he devised expedients which have largely lessened the disastrous effects of storm and flood.

The busy life he led left him little time for recording the results of his experience, but on several occasions he prepared papers dealing with subjects to which he had devoted much thought and attention. These are most instructive, and models of brevity and careful statement.

Mr. Curtis had a wide range of knowledge and an accurate, comprehensive memory, which doubtless added to his success. It was said among his associates that he never forgot a figure.

On June 15th, 1875, at Stockton, California, he married Mary Elizabeth Burton. In her he found a fitting helpmeet. Both as son and husband he was exceptional, manifesting in his domestic life the same disposition which had made him so respected and liked by subordinates and associates. For all about him he had ever a genial

smile; for the ambitious, a word of encouragement, and for the unfortunate, one of sympathy. He never forgot the social side of life, and even on a wearisome business trip, was wont to entertain his companions with enlivening repartee and anecdote, when no affair of moment was under consideration.

Mr. Curtis was not only an engineer and manager of rare judgment, but also a clever man of affairs, outside of technical matters. His assistance and advice were often sought in other enterprises and organizations.

Two years before his death his health began to break, but with the tenacity of purpose and loyalty to his employers which had characterized his long period of service, he gave of his best until compelled to seek complete change and rest. The end came at Highland Springs, California, on the twenty-fifth anniversary of his marriage, 1900.

His loss, great as it has been to the corporation with which he was so prominently identified, was not alone a public one. It was also distinctly a private loss, and those intimately associated with him can only recall him with the poignant regret caused by the departure of one possessing all the traits of a kindly gentleman, a well-balanced citizen and a true friend.

Mr. Curtis was elected a Member of the American Society of Civil Engineers on May 3d, 1882, and served as a Director from January 15th, 1890, to January 21st, 1891. At the time of his death he was Second Vice-President of the American Railway Engineering and Maintenance of Way Association. He was also a member of the Geographical Society of California; of the San Francisco Microscopical Society; of the Technical Society of the Pacific Coast; and of the Bohemian Club of San Francisco. In the two latter societies he was formerly a Director. To all of these he gave the same careful, precise attention which he gave to his railroad duties.

JAMES FRANCIS, M. Am. Soc. C. E.*

DIED DECEMBER 1ST, 1898.

James Francis was the second son of the late James Bicheno Francis, Past-President, Am. Soc. C. E., and Sarah W. Francis, and was born in Lowell, Mass., March 30th, 1840. His education was obtained mainly in private schools in the vicinity of Lowell and Boston. At the age of 20 years he entered the Lowell Machine Shop as an apprentice, studying and working in the different departments. Upon the call for troops at the outbreak of the Civil War he enlisted in the Second Massachusetts Regiment, and served until August, 1865. He was with the Army of the Potomac in the winter of 1862–63, participated in the battles of Cedar Mountain, Chancellorsville, Antietam and Gettysburg, was with the troops sent to quell the draft riots in New York City, and afterward served along the line of the Chattanooga Railroad and in Sherman's forces on the march to the sea. Mr. Francis was commissioned a Second Lieutenant in May, 1861, and rose to the rank of Lieutenant-Colonel in July, 1865. He was wounded in his left hand in the battle of Antietam, and lost his little finger by amputation.

After his discharge from the volunteer forces, Mr. Francis entered the engineering department of the Hoosac Tunnel in the autumn of 1865, as an assistant, and was engaged, chiefly, in surveying and leveling. Returning to Lowell in April, 1866, he became an assistant engineer of the Proprietors of Locks and Canals on the Merrimac River. In this position he devoted himself to the study of hydraulic works and especially to the important undertakings with which his father's name is associated. Upon the retirement of his father from active service, Mr. Francis was appointed, in January, 1885, Agent of the Company, in which position he had the management of the water power of the Merrimac River, and the charge of all the company's property.

The engineering problems involved in the control of the water power of the Merrimac River had been thoroughly worked out by the elder Francis, and the son, on assuming control, followed, without radical departures, the plans of work and methods of management which his father had inaugurated.

A notable original work was his scheme for the regulation of the power of the Concord River at Whipple's Falls, Lowell. The conflicting interests had, for years, engaged in litigation over the matter,

* Memoir prepared by the Secretary from papers on file, and by abstract of a Memoir published in the *Journal* of the Association of Engineering Societies.

without approaching a settlement, when the Court referred the whole question to Mr. Francis. He designed a system for the regulation of the power, which has been in operation since 1894, to the satisfaction of the parties in interest.

Mr. Francis' dealings with corporations, as with individuals, were marked by absolute impartiality, and his honesty of thought and purpose were apparent in all his relations with his fellow-men. He was severely hurt during work on the Pawtucket Canal in 1888, both legs being broken. He recovered from these injuries, but a few months before his death he was thrown from a carriage. He never regained his former vigor after this accident, but lost strength steadily until his death.

He was married to Caroline, daughter of Franklin Forbes, of Clinton, Mass., on July 19th, 1873. Three children were the result of this union: Joseph S., Clara and Duncan F. The first two survive their father, but the latter died at an early age. Mrs. Francis died on August 13th, 1889. On July 12th, 1892, Mr. Francis married Mary C., daughter of Thomas A. Carew, of Cambridge, Mass., who survives him.

Mr. Francis served as a member of the Lowell Board of Aldermen in 1884 and 1885. He was a director in the Lowell Gas Light Company and in the Railroad National Bank, and a trustee and member of the Board of Investment of the Mechanics Savings Bank.

Mr. Francis was elected a Member of the American Society of Civil Engineers on January 4th, 1893.

He was also a Member of the American Society of Mechanical Engineers, the Boston Society of Civil Engineers, the Institution of Civil Engineers of Great Britain, the Loyal Legion, the Massachusetts Military Historical Society, the Victoria Institute, the Philosophical Society of Great Britain, and the Unitarian Society.

RANDELL HUNT, M. Am. Soc. C. E.*

DIED JANUARY 24TH, 1898.

Randell Hunt was born in New Orleans, October 30th, 1856. He was graduated at Yale with degrees in engineering and philosophy. After leaving college, his first practical experience was gained in connection with the New York Public Parks.

In 1878 he established an office in Dakota, and identified himself thoroughly with the principal engineering works of the then very active and prosperous West. As a specialty, he devoted himself to bridge structures and foundations, and all through his professional career these were the particular branches in which he excelled and with which his name became prominently connected. Until 1883 he remained in Dakota, with the exception of a period in 1879, when, as hydraulic engineer, he was attached to the Mississippi River Commission, in the investigations of that great waterway.

From 1883 until 1888 he was located at St. Paul, Minn., and employed as constructing engineer by the Chicago, Burlington and Northwestern Railway. He had charge of the bridgework, and, under his direct supervision, the noted Chippewa River Bridge was built.

In 1888 he went to San Francisco and began a general engineering practice in the line of his specialty. Many of the bridges of this State were designed by him and built under his direction. In 1889 he was made the Engineering Expert of the contracting firm of Antonelle & Doe, and his name became very prominent in the controversy regarding the concrete foundations for the extensive State work on the sea wall at the foot of Market Street, in San Francisco, which caused considerable interest at the time, he contending that the system of sinking the wall by means of open floating caissons possessed innumerable advantages over the method of constructing coffer-dams for this work. He devised means for an efficient and rapid execution in this direction, and defended his position so ably that he converted the authorities to his ideas. The Harbor Commissioners finally permitted the use of this system, and the work was successfully carried out. The total length of the wall to be constructed aggregated 450 ft.; seven caissons were used, six of them 70 ft. long and one 34 ft. They were sunk in depths of from 10 ft. at low water stage to 17 ft. at high water. Only one set of sides and ends was used for the six large caissons. The sides and ends were attachable and detachable to and from the grillage forming the bottom of the structure. These designs were very interesting, and all through this extensive work

* Memoir prepared by Otto Von Geldern, M. Am. Soc. C. E.

this method of operation gave great satisfaction, for no mishap of any serious consequence occurred.

With Mr. Hunt, engineering was more than the mere means of making a livelihood. With an inborn love for his profession, he gave to every case before him a careful and deliberate study; and if he advocated his designs and upheld them with all the vigor of his energetic character, it was because he was led by an honest conviction that he contended for that which he knew to be right, and that nothing should influence him to swerve from the path which he had laid out.

In 1890 the firm of Doe & Hunt, engineering contractors, was established, and it carried on a successful business for a number of years. Here, Mr. Hunt displayed great energy and activity, and the results of his labor are manifest to-day in a great variety of existing public works. His last work under the name of the firm was the very important construction of the headworks and canal of the Turlock Irrigation District. This extensive engineering operation would have been carried to a successful completion by him had it not been for the suspension of all irrigation enterprises, by reason of legal and financial difficulties which threatened disaster to almost every irrigation district in California, the problem of recovery therefrom not having been solved to this day.

In 1897 Mr. Hunt's services were engaged by the Commission which had been charged by the Government to decide as to the respective merits of Santa Monica and San Pedro Harbors for deep-water improvement and shelter to vessels. Here he became the expert in the work of making borings in two localities, in order to establish the composition of the materials of the respective harbor bottoms. Although then suffering from a malady which proved incurable, and being very ill at the time, he carried out this trying work to the end, at a season when the conditions of the weather made it a severe test for a man in health to have been so constantly in attendance as he was.

This indomitable energy, to carry out whatever he had undertaken, was one of the principal characteristics of his nature. Physical indisposition could not incapacitate him. As long as he could be about he performed his full share of the work—and this he did to the very end of his useful life.

Socially, he was the most estimable of men. His early training and education had opened his mind to all the ennobling influences of culture and art, and, while he devoted himself to the advancement of his profession, he never lost sight of the many other elements that make up human progress. Classic literature and the literature of the day were known to him as to few others, and he delighted to converse on these subjects with those about him who enjoyed his more intimate acquaintance. He was a most genial companion, alive to every interest, kind hearted, devoted to his family and friends, and always ready to assist others in giving aid and advice.

His father, the Hon. William H. Hunt, was a very prominent man in his day. Under the administration of President Garfield he was Secretary of the Navy; after Garfield's death he was sent to Russia as Ambassador to represent the United States. He died in St. Petersburg in 1885, full of honors and mourned by two great nations.

In Randell Hunt the American Society has lost one of its most prominent members. He will be remembered, not only as an engineer of high quality, but as a man of many virtues and broad principles, who made it the maxim of his life to maintain fearlessly an honest conviction under all circumstances.

He died January 24th, 1898, after a lingering illness of several weeks.

Mr. Hunt was elected a member of the American Society of Civil Engineers, May 2d, 1883.

NILES MERIWETHER, M. Am. Soc. C. E.*

DIED DECEMBER 28TH, 1900.

Niles Meriwether was born in Christian County, Ky., on January 26th, 1830, of parents who came of old Virginia stock, and who had gone to Kentucky in the early part of the century.

At the age of eighteen, both his parents being dead, he entered the engineering field, taking a position as a rodman on the Nashville and Chattanooga Railroad, then in process of location. He remained on this railroad, in various positions, for five years.

In 1853, he became First Assistant Engineer on the Mississippi and Tennessee Railroad (now a branch of the Illinois Central Railroad), his brother, Minor Meriwether, being Chief Engineer. In 1857, his brother resigned, and Niles became Chief Engineer, which position he held until 1862, when the occupation of Memphis by the Union Army made further railroad work impossible.

In 1865, this road being practically destroyed by the contending armies, he interested himself in securing the means to rebuild it, in which he was successful.

In 1868, he became Chief Engineer of the Memphis and Charleston Railroad (now a part of the Southern System), and held that position for eight years, during which time he built the Middleton and Ripley Branch and extended the Tullahma and McMinnville Branch to Jasper, Tenn. He also constructed most of the important bridges of this line which had been much injured during the war.

In 1875, as Chief Engineer, he took charge of the consolidated roads formerly known as the Southern and Mississippi Central, and extending from New Orleans to Cairo, Ill.

In 1877 he began the construction of the Natchez and Jackson Railroad, from Natchez to Jackson, Miss., but the yellow fever epidemic of 1878 so depleted the finances of that country that in the following winter the construction was suspended.

In February, 1879, Major Meriwether accepted the position of City Engineer of Memphis, and held this office for fourteen years, during which time he did more than any other man to restore an almost ruined city to its present prosperous condition.

In March, 1897, he took charge of the construction of a branch of the Mobile and Ohio Railroad, running from Montgomery, Ala., to Columbus, Miss., and completed the line in May, 1899. His last work was as Superintending Engineer of Elmwood Cemetery, in Memphis, which occupied his time until two weeks previous to his death.

* Memoir prepared by Mrs. M. M. Betts, of Memphis, Tenn.

During these fifty-two years of active work Major Meriwether was frequently called on to act as arbitrator or consulting engineer on many important pieces of engineering work all over the South.

He was elected a Member of the American Society of Civil Engineers on November 1st, 1871, and, at the time of his death was President of The Engineering Association of the South.

In 1855 he married Miss Lide Parker Smith, of Accomac Co., Va., and their union of forty-five years was a rarely happy one. His wife and two daughters, Dr. Lucy V. Davies, of New York, and Mrs. M. M. Betts, of Memphis, survive him and cherish his memory.

MARC JOHN REISEGER, M. Am. Soc. C. E.*

DIED MAY 26TH, 1900.

Marc J. Reiseger was born October 31st, 1861, near Groningen, The Netherlands, where he attended the public schools, going from the high school there to a college at Delft. After concluding his college career, he entered the employ of the Government as Engineer in Charge of Railroad Bridges, the railroads in that country being owned by the Government.

On May 1st, 1887, Mr. Reiseger left his native land for the United States. For a time he worked as a common laborer on the County Court House in Cheboygan, Mich., his object being to acquire a knowledge of American architecture, etc. He next went to Grand Rapids, Mich., and entered the office of a prominent architect there. In 1888 he left Grand Rapids for Muskegon, Mich., where he had been offered a similar position, which he subsequently resigned for the purpose of opening an office for himself in the same city. The business was eminently satisfactory. Among the more prominent buildings designed by him and erected under his supervision are the North Muskegon School House, the Fox Cracker Factory and the Chase Piano Factory.

In April, 1890, he took up his residence in Greenville, Mich., with the intention of engaging in manufacturing there, but in 1891 he returned to Muskegon. In 1893 he entered the United States Engineering Office in Grand Rapids, and in 1894 secured a position with Keepers and Thatcher Wynkoop, better known as the Detroit Bridge and Iron Works of Detroit, Mich., which firm subsequently became Keepers and Thatcher. While in their employ he was Engineer in charge of bridges built at Albion and Tecumseh, Mich., and Paterson, N. J. He was also for a time in the Company's office in Little Rock, Ark., on which occasion he prepared the plans for the bridge erected by them at Topeka. In April, 1899, Mr. Reiseger returned to Grand Rapids, and organized the Grand Rapids Bridge Company, of which he became President and General Manager on its incorporation, January 31st, 1900. In addition to many smaller bridges, the Grand Rapids Bridge Company built the metal-concrete bridge at Battle Creek, Mich.

Mr. Reiseger was elected a Member of the American Society of Civil Engineers on December 7th, 1898.

Early in 1900 Mr. Reiseger's health began to fail, as a result of too close application to business, and on May 26th, 1900, he died at his residence, 241 North Prospect Street, Grand Rapids, Mich., of tuberculosis-meningitis.

* Memoir prepared by Paul van Deinse, Esq.

WILLIAM HOWARD WHITE, M. Am. Soc. C. E.*

DIED DECEMBER 11TH, 1895.

William Howard White was born in Watertown, Mass., on February 21st, 1847. He was the son of William Abijah and Harriet Tilden Sturgis White. His father's sister, Maria, was the first wife of James Russell Lowell. Mr. White's father and mother died when he was a little boy, and he was taken into the family of and brought up by Mrs. Francis George Shaw, his mother's sister.

In July, 1865, Mr. White was graduated from the Lawrence Scientific School, Harvard University, in the course of civil engineering (*magna cum laude*), and then commenced practice as a civil engineer, in which profession he distinguished himself with great honor.

His first engineering work was in connection with the sewerage of New York City, from August 9th, 1865, to January 10th, 1867. He then became engineer in charge of the construction of seven miles of the Sullivan and Erie Railroad, in Pennsylvania, until March 14th, 1868.

From May 13th, 1868, to March 31st, 1870, he was an Assistant Engineer on the Burlington and Missouri River Railroad. From 1870 to 1873, as Assistant to Colonel Mendell, U. S. Engineers, he worked on the original survey of San Pedro Harbor. The following year he spent in Europe, studying foreign engineering and languages.

Mr. White afterward became Chief Engineer of the New York and New England Railroad System, covering about 450 miles. During 1879–1883 he was Assistant Chief Engineer of the Chicago, Burlington and Quincy Railroad, having charge of all the engineering work on the Iowa lines, embracing some 900 miles.

At the end of this period Mr. White again went to Europe, where he spent two years in studying foreign sanitary engineering and appliances.

For seven years following 1885 he was a Consulting Engineer in New York City with a branch office in Chicago. Some of the clients by whom he was consulted were Messrs. Brown Brothers & Company, of New York; Carey & Whitridge, attorneys for an English investment company, and Messrs. Morton, Bliss & Company, of New York. On the strength of reports made by him the Pillsbury & Washburn Mills, at Minneapolis, having an aggregate capacity of 20 000 bbls. of flour per day, were purchased, and action taken on properties in Kentucky aggregating $5 000 000 in value.

Mr. White was elected a Member of the American Society of Civil Engineers on March 5th, 1873, and served as a Director for the year 1886.

In 1878 Mr. White was married to Margaret Howard Parker, of New

* Memoir prepared by W. A. Nicholls, M. Am. Soc. C. E.

York City, and in the fall of 1892 they went to Redlands, Cal., from South Orange, N. J., with their three children, seeking a milder climate for the benefit of Mr. White's failing health. Some months previous to this Mr. White had visited Redlands and purchased 24 acres of orange lands, and here he built a home.

He was a man of great intellectual force, and always prominently identified himself with the best interests of the community in which he resided. He died in Redlands, December 11th, 1895.

His last professional work was the giving of expert testimony, from the bed from which he never was to arise, before a Commission, appointed for the purpose by the Superior Court, in a suit involving important questions in water development near Redlands.

Mr. White presented several valuable papers before the Society, and was a frequent contributor to the discussions.

DOMINIK LINDENTHAL, Assoc. M. Am. Soc. C. E.*

DIED JUNE 7TH, 1900.

The cabled news of the tragic death of Dominik Lindenthal, Assoc. M. Am. Soc. C. E., on June 7th, 1900, in Cuba, came to his family and friends like a thunderbolt from a clear sky. They knew that his health was affected, but they were not prepared for a fatal termination. A letter from him, received the day before his death, had announced to his family his intention to return to New York on July 1st, and that he had already engaged his home passage.

At the time of his death he was the Manager and Chief Engineer of the Cuban Steel Ore Company, opening up iron ore quarries, and building shipping docks and a railroad at Guama, about 35 miles east of Santiago de Cuba. It was not his first work in Cuba, he having been there several times before on the surveys and construction of different railroads.

He had, years before, successfully resisted an attack of yellow fever, and therefore was thought to be inured to the tropical climate. But in the beginning of 1900, he began to suffer from malarial fever, from which he obtained temporary relief during a business trip to New York and Philadelphia, in May, 1900. Foreseeing that, during the coming hot season, his weakened health would not endure the strain of the great responsibility of the important work entrusted to him, he had given notice, to the officers of the Company, of his resignation, which had been accepted very reluctantly. He returned to Cuba in the middle of May merely to prepare his work for transference to his successor. But immediately after his arrival there he had a relapse; the attacks of malarial fever became more severe, and his mind became affected. For four days he neither ate nor slept, and in a fit of insanity, he killed himself with a revolver, while unwatched.

He was then thirty-four years of age, in the fairest years of mature manhood, having been born in Bruenn, Austria, on the 10th of October, 1866. He was the youngest son of Dominik Lindenthal, a substantial burgher and master cabinet maker, who died in 1889. The Lindenthals belonged to that now mostly extinct type of German burgher families, in which the membership in the craft or guild had descended with the old home and traditions from father to son for generations.

Dominik, named after his father and grandfather, was at first intended to continue the business and family traditions of his ancestors, and to become an artistic cabinet maker. But his natural brightness

* Memoir prepared by Paul S. King, M. Am. Soc. C. E.

and intense desire for study led to his being sent to college (Staats Gymnasium), first in Bruenn and then in Triest, from which he was graduated near the head of the class. He was regularly matriculated at the University of Vienna in the year 1885 for the study of medicine, to the practice of which he then looked forward as his professional ambition. At the same time he complied with his military obligations as a one-year volunteer in the Austrian army, in which he had the rank of lieutenant.

Besides his classical studies, he had also obtained through his elder brother Ernst, Professor of Mathematics at that time in Triest, a thorough education in the physical sciences, and when, in the summer of 1887, he was invited by his eldest brother Gustav, then a civil engineer in Pittsburg, Pa., to come to the United States, he came over well prepared for an engineering career, which he then preferred.

His first experience was in the shops of the Bethlehem Iron Company, in Bethlehem, Pa., which he entered as a workman, to familiarize himself with the practical work in the machine shop from the bottom up; he passed on to building operations and the construction of machinery foundations.

From there he stepped into the position of leveler and draftsman on the Wheeling and Harrisburg Railroad, where he was under the direction of Paul S. King, M. Am. Soc. C. E., Engineer in Charge of Surveys.

His ability and love of hard work caused him to be selected by the Juragua Iron Company for the engineering staff, and sent to Cuba to survey and construct a railroad and iron ore mines in the rugged country near Santiago de Cuba, where he was employed until April, 1889.

Returning to the United States, he occupied the position of Assistant Engineer on the surveys for the extension, at that time contemplated, to the anthracite coal mines of the Maryland Central Railroad and the Baltimore Belt Railroad, which work was in charge of John B. Bott, M. Am. Soc. C. E., as Principal Assistant Engineer, under Gustav Lindenthal, M. Am. Soc. C. E., as Chief Engineer.

In 1890 he took charge of the construction of the foundations, masonry and superstructure for the McKeesport and Duquesne Highway Bridge across the Monongahela River, of which his brother Gustav was the Chief Engineer.

From this position, he stepped into a Division Engineership on the extension and double tracking of the Lehigh Valley Railroad, from Sayre, Pa., to Buffalo, N. Y., under his former chief and friend, P. S. King, as Chief Engineer. On this work he was employed until July, 1892.

In the early autumn of that year he went on his second trip to Cuba, as chief of a party of surveyors for the railroad to the man-

ganese mines, for the Ponupo Mining and Transportation Company, in Santiago de Cuba, on which work he remained until January, 1893.

Again returning to the United States, he became Accountant Engineer for Coleman, Ryan and Brown, contractors for the new Croton Dam, Croton-on-Hudson, where he remained until October, 1895.

His next position was as Accountant Engineer for H. H. Brown, contractor for the revision and improvements on the New York, New Haven and Hartford Railroad, at Roxbury, Mass.

In all these positions he had occasion to acquire great experience in the practical execution of work and in the handling of working forces on a large scale. He was highly regarded for his technical ability, sterling honesty and untiring industry, which made him to his employers a very valuable man.

In 1897 Dominik became office assistant to his brother Gustav, who had in the meantime moved his engineering office from Pittsburg to New York. His skill as a fine draftsman and designer found a ready field in his brother's work.

In the fall of 1899 he went the third time to Cuba, again with his former chief, Paul S. King. This was the work for the Cuban Steel Ore Company, mentioned at the beginning of this memoir, and from which Mr. King, through ill health, was compelled to resign in the autumn of 1899, leaving Dominik Lindenthal as his successor. He was in charge of the surveys and construction for the railroad, ore docks, and the opening of the iron ore quarries, when his untimely death occurred.

Of his immediate family, a widow and a daughter of four years survive.

By his employers the deceased was highly regarded for his integrity and manliness, and by his closer friends for his accomplishments as an educated man. He was a linguist, who had mastered—in addition to his native tongue of German—English, French, Italian, Spanish and Bohemian; and was an accomplished performer on the piano—a lover of music. His reticent manner did not invite easy friendship, but those friends whom he had loved him dearly, and mourn deeply his all too early death.

There was every prospect that, had he lived, he would have attained a high reputation in his chosen profession for executive ability and sound judgment in the direction and organization of engineering and construction work, which was more to his taste than the designing work in the office, in which he was also very proficient.

He was elected an Associate Member of the American Society of Civil Engineers on March 4th, 1896. He was also a Member of the German Technical Society of New York, in the reorganization and direction of which, as one of the officers, he had taken a conspicuous part.

JOSEPH RUGGLES RICHARDS, Assoc. Am. Soc. C. E.*

DIED SEPTEMBER 28TH, 1900.

Joseph Ruggles Richards, oldest child of Wyatt Richards (born at Hardwick, Mass., March 8th, 1802, died in Boston, February 9th, 1872), and Sarah Page Ruggles (born at Roxbury, Mass., June 9th, 1796, married April 5th, 1827, died in Boston, March 17th, 1878), was born at 63 Myrtle St., Boston, February 18th, 1828.

He obtained his education in the public schools of Boston, passing through the various grades of the Mayhew School, on Chardon St., and, finally, being graduated from the English High School in the year 1845, winning one of the six Franklin Medals for scholarship. He was especially good in mathematics, a taste which followed him all through his professional life; nothing pleasing him more than to work up a truss or difficult problem in construction, or to figure out the dimension figures on a set of plans, working for an hour at a time to find the missing inch to tie a column of figures. When he had finished, one was sure the figures were correct. His natural taste for drawing is shown in the many drawings he made when a boy.

His expense accounts, carefully kept from youth up, bear witness to his businesslike methods.

Under the date of October 6th, 1845, he records:

"I, J. R. Richards, this day entered the office of Mr. Gridley J. F. Bryant, 4 Court Street (Boston), for the purpose of serving my apprenticeship under him in the Architectural profession. Seventeen years old on the 18th day of February, 1845."

At the end of the first year he began to receive regular pay, in ever increasing amounts as the half years went by, turning also many an honest penny by over work, writing, translating French, and odd work on his own account.

The many embryo architects who worked with him under Mr. Bryant, then one of the most active and influential architects in the country, will bear witness to Mr. Richards' faithfulness and ability, and tell with admiration of the amount of work he could "throw off."

The systematic time cards or diaries he kept show where each hour was spent; and the number and variety of the works he undertook is remarkable.

On January 1st, 1853, he opened an office on his own account at 46 Court St., corner of Tremont St., Boston, in a building famous from the names of Washington and Lafayette associated with it, and famous later for having Daniel Webster as a tenant.

*Memoir prepared by William P. Richards, Esq., Boston, Mass.

In July, 1865, the firm of Richards and Park was formed by the admission of William S. Park, his brother-in-law. The firm was dissolved in 1872, Mr. Richards continuing the business alone.

On October 1st, 1880, he admitted his son William P. Richards into partnership with himself, ending it only with his death on September 28th, 1900.

His list of clients contains the names of many honored people, and his work, though principally confined to the neighboring States, extended to New York, Pennsylvania, Louisiana, Alabama, California, Wisconsin, Kansas, Florida and Minnesota.

The City of Boston early employed him, and for a number of years he designed for it schools, engine-houses, armories, stables and other structures.

The State of Massachusetts also appears early, as a client, and at intervals up to a recent date. At one time he made plans for work on the State House, and at another he was one of the Commissioners on extensive alterations to it, executed for them by Mr. G. J. F. Bryant.

The State Capitol at Montpelier, Vt., was erected under his supervision, the drawings of another architect being handed to him to carry out and finish, and in 1885–86 he designed and executed an annex to this building for the Supreme Court and State Library.

Harvard, Amherst Agricultural, Dartmouth, Williams and Hamilton Colleges, also Baker University, Kansas, appear on his books; and he erected important buildings for them.

The cities of Cambridge, Brookline, Lowell, Woburn, Blackstone, Mass., and Kenosha, Wis., employed him on schools and various public works.

The counties of Suffolk and Franklin each had their Court Houses enlarged and remodelled by him.

A stone church in Greenfield and a brick church in Taunton show his ability, as also brick and stone libraries in West Brookfield, Greenfield, Sudbury (the latter again enlarged in 1894), the Waverly House, in Charlestown, and the Crawford House, in Boston.

Numerous large stores and business blocks, and town, city and summer houses in Boston and neighboring towns were planned and carried out by him.

Among his more recent and larger works are the "Jarvis" and "Stanstead" apartment houses in Cambridge, "White" apartment house, Commonwealth Ave., Boston, Five Cents Savings Bank Building in Woburn, Royal Arcanum Building, Boston, and Colored Odd Fellows' Building, Boston.

Throughout his entire practice it had been his custom to lay out and do most of the important office and outside work himself; his draughtsmen, in consequence, few in number, doing what he could not accomplish in the busy days.

Of him *The American Architect and Building News* speaks, as one:

"Whose unfailing courtesy and interest in artistic matters had made him for many years a favorite in the profession. Although his works belong rather to the last generation than to this, he carried out in his younger days very many mercantile and other buildings, characterized by a quiet good taste which was then perhaps the best quality that such architecture could show."

Outdoor sketching in pencil and water color was a constant pleasure to him, and his leisure moments in the office were often taken up in working with his brush. A large collection of pictures and studies give evidence of a remarkable taste and talent for water-color painting.

As the years passed he gradually left more and more of the office work and outside duties to the younger partner, but, without fail, except when sickness prevented, and that rarely, would come to the office and attend to his duties.

At the close of office hours, except for rare occasions, home was the next object in view, and, arrived there, it would again be a rare occasion, as time went by, for him to spend the evening away, though he was peculiarly sociable in his temperament and enjoyed the company of his friends. Masonic cares occupied his time early in his career, but he gradually dropped the active cares and attendance at meetings. He was admitted to Amicable Lodge, Cambridgeport, in August, 1856; St. Paul's Royal Arch Chapter, in 1859, and Boston Commandery, Knights Templars, in 1860.

He was married to Mary A. Phillips of South Natick, Mass., daughter of Thomas and Clarissa Brackett Phillips, on August 27th, 1851, and commenced housekeeping in Cambridge, where he watched the gradual building up of residences, schools and library on the acres of vacant land near him. To reach his Boston office, he profited by the slow change from omnibus to horse car, and from horse to electric car, the first horse cars from Cambridge passing his door. The Fitchburg Railroad had a branch track almost to Harvard Square, now discontinued, which he used on first coming to Cambridge.

His wife and daughter and one of two sons survive him.

As a referee, he acted acceptably in a number of cases, and as executor or administrator he settled up several estates successfully and happily. As Trustee for the North End Savings Bank for a number of years, he rarely lost a meeting with his co-trustees, and his advice on investments in real estate was invaluable.

Though actively interested in the political life of the town and State, and never failing to go to the polls to vote, he never accepted public office.

On May 22d, 1867, he attended the first meeting called by the architects of Boston for the purpose of forming a Society of Architects, and on September 3d he was elected a Fellow Member, which membership he

kept up until his death. He was a loyal member to that Society and his fellow architects, was ever ready to help it or them, and his fairly regular presence at the monthly meetings of the Society will be missed.

He was elected an Associate of the American Society of Civil Engineers on February 4th, 1880, and, though distance from New York prevented him from taking an active interest in all the meetings, he looked forward with pleasure to the Annual Meetings and Annual Conventions which make up a large part of the social life of the Society, and, when he could, joined these gatherings.

JOHN MONTGOMERY TOUCEY, F. Am. Soc. C. E.*

DIED SEPTEMBER 29TH, 1898.

John Montgomery Toucey was born in Newtown, Conn., on July 30th, 1829. He prepared for Trinity College, but, finding that his tastes did not lie in the direction of the ministry, he took up the profession of teaching. After pursuing that profession for two years, he began railroad work as a station agent at Plymouth, now Thomaston, on the line of the Naugatuck Railroad, then in process of construction.

Soon after, he was placed in charge of the construction of the railroad between Waterbury and Winsted—heavy freshets having severely damaged it—and was highly commended for the rapidity with which the work was carried out under his direction. He was married in 1851, and secured employment with the Madison and Indianapolis Railroad, and, subsequently, as a freight agent on the Morris and Essex Railroad. In the spring of 1855 he entered the service of the Hudson River Railroad Company, as a passenger conductor, and afterward became its agent at East Albany. In 1862, Samuel Sloan, then President of the road, appointed him Trainmaster, and so well were his duties performed that he was appointed Assistant Superintendent in 1867.

In the same year he resigned, to accept the office of General Superintendent of the Delaware, Lackawanna and Western Railroad, but retained the office only two months, as he was recalled to the Hudson River Railroad and made its General Superintendent in full charge of the line. He continued in charge of this section of the road after the consolidation with the New York Central in 1869, and in 1881 his authority was extended over the lines west of Albany. In February, 1890, the office of General Manager was created for Mr. Toucey, and this office he held until it was abolished, eight years later, after the election of Mr. Callaway as President. A month later he presented his resignation, and was placed on the retired list at half-pay.

For forty-three years Mr. Toucey was a responsible officer of the New York Central and Hudson River Railroad. He was a man of great energy and resolution, his dominant trait being unwearying fidelity; and he had, in particular, the gift of managing trains and moving passengers and traffic expeditiously and at minimum cost. He was bold in assuming responsibility, but had a keen desire to learn what was best in the practice of others. In his personal relations with the employees of the railroad, he was genial and sympathetic, and the older men in the service were strongly attached to him

* Memoir prepared by the Secretary from papers on file at the House of the Society.

on account of his friendly interest in their associations, his unostentatious charity, and his management of the Christmas dinners provided for the men.

The railroads of the United States are indebted to Mr. Toucey for many improvements. He was first to introduce interlocking switches in the United States. These were placed in the Grand Central Yard. The present circular form of scoop for taking water for locomotives from a tank between the tracks is due to his experiments at Montrose in conjunction with Mr. Wm. Buchanan. He was Manager of the Grand Central Station at the time the entire system of tracks was changed at that locality, and proposed and urged the abolition of the crossings at grade.

At the World's Congress of Railways, in London in 1895, as a result of the profound impression made by Mr. Toucey's remarks, with regard to the speed of the Empire State Express, several representatives of the continental lines have inspected the track of the New York Central, and have made reports to their companies confirming Mr. Toucey's statements. At the Congress Mr. Toucey was accorded great respect as a representative American railroad man.

Mr. Toucey wrote little besides his personal and official correspondence, seldom spoke in public, and was reluctant to appear in conspicuous positions. His personality, therefore, was known to comparatively few, save those with whom he had business relations. He had taken little rest from active work since his first engagement in his boyhood, and he suffered from illness for several months before his death.

Mr. Toucey became a Fellow of the American Society of Civil Engineers on May 17th, 1870.